IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Pontanari, et al.
Serial Number:	10/543,080
Filed:	July 20, 2005
Art Unit:	3681
Examiner:	Knight, Derek Douglas
Title:	Electronic Differential Lock Assembly

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Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Dear Sir:

Appellant submits this Appeal Brief pursuant to the Notice of Appeal filed December 5, 2008. Fees in the amount of $540.00 may be charged to Deposit Account No. 50-1482 in the name of Carlson, Gaskey & Olds. Any additional fees or credits may be charged or applied to the same Deposit Account.

REAL PARTY IN INTEREST

The real party in interest is Meritor Heavy Vehicle Systems Cameri SpA, assignee of the present invention as recorded at reel/frame 016913/0887.

RELATED APPEALS AND INTERFERENCES

There are no prior or pending appeals, interferences or judicial proceedings related to this appeal, or which may directly affect or may be directly affected by, or have a bearing on, the Board's decision in this appeal.

STATUS OF CLAIMS

Claims 1-20 and 24-27 are pending, rejected, and appealed. Claims 21-23 have been cancelled.

STATUS OF AMENDMENTS

All amendments and responses have been entered and considered.

SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 is directed to a differential locking mechanism 124 for a drive axle 108 that includes a differential 116 with a differential gear assembly 42 supported within a differential case 44 (see Page 5, lines 18-19; Page 8, lines 7-20; Figures 2 and 5). Axle shafts 118 are driven by the differential gear assembly 42 for rotation about an axis 122 (Page 8, lines 14-18; Figure 5). A shift collar 126 is movable between an unlocked position (Figure 7) where speed differentiation between the pair of axle shafts 118 is permitted and a locked position (Figure 8) wherein the shift collar 126 directly engages the differential case 44 such that the differential case 44, the shift collar 126, and the pair of axle shafts 118 are fixed for rotation together (Page 9, lines 9-16, Figure 8). An electronic actuator 128 is responsive to an electronic signal 132 to move the shift collar 126 from the unlocked position to the locked position (Page 8, lines 21-29; Figures 5 and 7-8). A resilient member 142 returns the shift collar 126 to the unlocked position and surrounds an outer end portion 162 of the shift collar 126 (Page 9, lines 2-4; Page 8-14; Figures 7-8).

Independent claim 9 is directed to a drive axle assembly 108 with a locking differential 116 that includes a driving input 106 defining a longitudinal axis 120, a carrier 110 including a pinion gear 212 driven by the driving input 106 and a ring gear 114 in meshing engagement with

the pinion gear 212 (Page 8, lines 6-18; Figure 5). A differential 116 includes a differential gear assembly 42 supported by a differential case 44 wherein the ring gear 114 is attached to the differential case 44 to drive the differential gear assembly 42 (Page 8, lines 14-20; Figures 1 and 5). Axle shafts 118 are driven by the differential gear assembly 42 for rotation about a lateral axis 122 that is transverse to the longitudinal axis 120 (Page 8, lines 16-20; Figure 5). A locking mechanism 124 includes a shift collar 126 and an electronic actuator 128 for controlling movement of the shift collar 126 wherein the shift collar 126 is movable between an unlocked position (Figure 7) where speed differentiation between the pair of axle shafts 118 is permitted and a locked position (Figure 8) wherein the shift collar 126 is moved into locking engagement with the differential case 44 in response to an electronic signal 132 such that the differential case 44, the shift collar 126, and the pair of axle shafts118 are fixed for rotation together about the lateral axis 122 (Page 8, lines 21-29; Page 9, lines 9-16; Figures 7-8). The locking mechanism 124 includes a resilient member 142 that returns the shift collar 126 to the unlocked position and which surrounds the shift collar 126 and reacts between the electronic actuator 128 and the shift collar 126 (Page 9, lines 2-4; Page 10, lines 12-14; Figures 7-8).

Independent claim 13 is directed to a drive axle assembly 108 with a locking differential 116 that includes a driving input 106 defining a longitudinal axis 120, a carrier 110 including a pinion gear 212 driven by the driving input 106, and a ring gear 114 in meshing engagement with the pinion gear 212 (Page 8, lines 6-18; Figure 5). A differential 116 includes a differential gear assembly 42 supported by a differential case 44 wherein the ring gear 114 is attached to the differential case 44 to drive the differential gear assembly 42 (Page 8, lines 14-20; Figures 1 and 5). Axle shafts 118 are driven by the differential gear assembly 42 for rotation about a lateral axis 122 that is transverse to the longitudinal axis 120 (Page 8, lines 16-20; Figure 5). A locking mechanism 124 includes a shift collar 126 and an electronic actuator 128 for controlling movement of the shift collar 126 wherein the shift collar 126 is movable between an unlocked position (Figure 7) where speed differentiation between the pair of axle shafts 118 is permitted and a locked position (Figure 8), and wherein the shift collar 126 is moved into locking engagement with the differential case 44 in response to an electronic signal 132 such that the differential case 44, the shift collar 126 and the pair of axle shafts 118 are fixed for rotation

together about the lateral axis 122, and wherein the electronic actuator 128 comprises a coil surrounding the shift collar 126 wherein the electronic signal 132 powers the coil to move the shift collar 126 (Page 8, lines 21-29; Page 9, lines 9-16; Figures 7-8). The shift collar 126 includes an inboard end 160 having a splined surface 168 and an outboard end 162, and the inboard end 160 has a greater diameter than the outboard end 162 (Page 10, lines 1-14 (Figure 9). The coil 128 defines a central bore 140 surrounding the shift collar 126 at the outboard end 162, and the shift collar 126 moves in an inboard direction in response to the coil 128 being powered via the electronic signal 132 such that the splined surface 168 of the inboard end 160 engages a mating splined surface 170 formed on the differential case 44 such that the differential case 44 is locked to the pair of axle shafts 118 (Page 9, lines 1-2; Page 10, lines 1-7, 15-23; Figures 7-9). An axle housing 112 substantially encloses the carrier 110 and the pair of axle shafts 118, and the coil 128 is supported by the axle housing 112 (Page 8, lines 7-10; Page 8, line 31 through Page 9, line 1; Figures 5 and 7-8). A resilient member 142 automatically returns the shift collar 126 to the unlocked position when the coil 128 is not powered and reacts between the coil 128 and a washer 144 mounted to the outboard end 162 of the shift collar 128 (Page 9, lines 2-4; Page 10, lines 8-14; Figures 7-10).

Independent claim 17 is directed to a method for controlling a differential lock assembly 124 for a drive axle 108 comprising the steps of:

(a) providing a differential 116 for driving a pair of axle shafts 118, the differential 116 including a differential gear assembly 42 supported within a differential case 44 and a shift collar 126 for selective engagement with the differential case 44 (see Page 5, lines 18-19; Page 8, lines 7-23; Figures 2 and 5);

(b) energizing a coil 128 surrounding the shift collar 126 (Page 8, lines 21-25; Figures 7-8);

(c) in response to step (b) moving the shift collar 126 from an unlocked position (Figure 7) where speed differentiation between the pair axle shafts 118 is permitted under predetermined conditions to a locked position (Figure 8) where the pair of axle shafts 118 rotate at a common speed by fixing the shift collar 126 to the differential case 44 (Page 9, lines 9-16, Figure 8); and

(d) providing a resilient member 142 that surrounds an end portion 162 of the shift collar 126 and reacts between the coil 128 and a portion of the shift collar 126, and returning the shift collar 126 from the locked position to the unlocked position with the resilient member 142 when the coil 128 is no longer energized (Page 9, lines 2-4; Page 8-14; Figure 7).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Claims 1-10, 12-20, 24, 25, and 27 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Keller (US 5030181) in view of Petzold (US 6886425).

B. Claims 11 and 26 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Keller (US 5030181) in view of Petzold (US 6886425) and further in view of Fogelberg (US 4561520).

ARGUMENT

A. Obviousness Rejection – Keller and Petzold

Claims 1-10, 12-20, 24, 25, and 27 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Keller (US 5030181) in view of Petzold (US 6886425).

Claim 1

Claim 1 requires a shift collar that directly engages a differential case when in a locked position. The examiner argues that Keller discloses a shift collar 18 that directly engages a differential case 24. Appellant respectfully asserts that Keller does not disclose direct engagement between a differential case and shift collar as defined in the claim. Element 24 comprises a clutch wheel with a hub 23 that engages with a sliding sleeve 18. The clutch wheel 24 does not comprise a differential case and one of ordinary skill in the art would not consider clutch wheel 24 as corresponding to the claimed differential case.

Claim 1 also recites the feature of a resilient member that surrounds an outer end portion of the shift collar. The examiner admits that Keller does not disclose this feature and argues that Petzold teaches this claimed feature. The examiner states that Petzold discloses a resilient member 46 that surrounds an outer end portion 44 of a shift collar 18, and argues that it would be obvious to substitute the spring configuration of Petzold for the spring configuration of Keller.

Specifically, the examiner argues that it would be obvious to modify Keller to replace the coil spring 26 with a plate spring positioned between the armature plate 19 and the coil 16 to allow for easier access to the spring for maintenance and removal (See Office Action dated February 26, 2008, Page 6, lines 4-8). Appellant respectfully asserts that there is no motivation or suggestion to modify Keller in the manner proposed by the examiner.

Keller is directed to providing a pre-assembled bushing unit 10 that is installed within a housing (see claim 1). The bushing unit includes the sliding sleeve 18, magnet 16, and plates 14, 15, 19 (see Figure 1). The coil spring 26 is externally mounted to react between a gear 28 and the sliding sleeve 18. Once the pre-assembled bushing unit is removed from the housing, the spring is immediately accessible for maintenance operations. Contrary to the examiner's assertion, making the examiner's proposed modification would make it more difficult to access the spring, i.e. maintenance and removal of the spring would not be easier than that which is already provided by Keller.

As set forth at MPEP 2143, to establish a prima facie case of obviousness there must be some suggestion or motivation to modify the reference, there must be a reasonable expectation of success, and the reference must teach or suggest all of the claim limitations. The teaching or suggestion to make the claimed modification and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Further, the proposed modification cannot render the prior art unsatisfactory for its intended purpose (see MPEP 2143.01 (V)) and cannot change the principle of operation of a reference (see MPEP 2143.01 (VI)). If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. In re Gordon, 7233 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). If the proposed modification would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959). Further, the United States Supreme Court recently confirmed that "when the prior art teaches away from combining certain know elements, discovery of a successful means of

combining them is more likely to be non-obvious" (KSR Int'lCo. v. Teleflex, Inc. et al., 127 S.Ct. 1727 (2007). See also MPEP 2145.

The examiner has pointed to no teaching in Petzold of any particular benefit to using the Petzold spring configuration in place of the Keller spring configuration. The examiner has only provided a general assertion that such a modification would be a simple substitution. In addition, there is nothing in Keller would have led one of ordinary skill in the art to believe that Keller's configuration was in any way deficient for Keller's purposes or was in need of modification. There certainly is nothing to indicate that the spring of Keller is difficult to access. Also, as discussed above, modifying Keller in the manner proposed by the examiner would make it more difficult to access the spring.

Further, Keller teaches away from positioning the spring in the manner proposed by the examiner. Keller states that the spring is arranged between the sliding sleeve 18 and the opposing hub collar 23 to ensure that when no current is flowing through the magnet that the drive gears will not accidently engage. See col. 2, lines 57-60. Keller also states that the arrangement of the drive gears radially outside of the springs facilitates the concentric installation of a single spring of the shaft and the use of a particularly short sliding sleeve is made possible. See col. 2, line 66 through col. 3, line 2. Finally, Keller also teaches a beneficial configuration (see Figure 1A) that minimizes an air gap 32 between armature and the magnet that facilitates starting and saves electricity. See col. 5, lines 1-16. The examiner's proposed modification would clearly defeat the beneficial features that are provided by Keller's present spring configuration.

Thus, appellant respectfully asserts that claim 1 is allowable over the recited combination of references because the references do not disclose, suggest, or teach all of the claim elements, and further because there is no motivation or suggestion to modify Keller in the manner proposed by the examiner.

Claims 2-4

For the reasons set forth above with regard to claim 1, claim 2 is also allowable. Further, claim 2 recites that electronic actuator includes a coil mounted to an axle component. The

examiner argues that Keller discloses a coil 16. Appellant respectfully asserts that element 16 of Keller is not a coil mounted to an axle component as defined in the claim. Instead, Keller discloses mounting a magnet within the locking mechanism itself. Thus, claim 2 is allowable over the recited combination. For similar reasons claims 3-4 are also allowable.

Claim 5

For the reasons set forth above with regard to claim 2, claim 5 is also allowable. Further, claim 5 recites that the resilient member reacts between the coil and an outboard end of the shift collar. The examiner argues that Petzold discloses this feature. Appellant respectfully disagrees.

As shown in Figures 1-2 of Petzold, each of the springs 36, 38, 46 reacts between an electromagnetic device 24, 26, 40 and a disc 22 that is centrally positioned on the shift dog 18. Neither reference discloses a spring that reacts between a coil and an outboard end of a shift collar as claimed. Thus, claim 5 is allowable over the recited combination.

Claim 6

For the reason set forth above with regard to claim 5, claim 6 is also allowable. Further, claim 6 recites the structure of a washer that is fixed to the outboard end of the shift collar for reacting with the resilient member. The examiner argues that Petzold discloses a washer 22 mounted to a shift collar. However, as shown in Figures 1-2 of Petzold, disc 22 is centrally positioned on the shift dog 18. Petzold clearly does not disclose, suggest, or teach fixing a washer to an outboard end of a shift collar to react against a resilient member as claimed. Thus, claim 6 is allowable over the recited combination.

Claim 7

For the reasons set forth above with regard to claim 2, claim 7 is also allowable. Further, claim 7 recites that the shift collar includes an inboard end having a splined surface and an outboard end for supporting the resilient member, with the inboard end having a greater diameter than the outboard end.

Keller discloses a sleeve 18 with a splined surface at one end but this sleeve does not have a reduced diameter portion that supports a resilient member as claimed. Petzold discloses a shift dog 18 that has the same outer diameter dimension at both ends. The shift dog includes a center notch that receives disc 22. As such, neither reference discloses, suggests, or teaches the combination of a shift collar having a smaller diameter at one end that supports a resilient member. Thus, claim 7 is allowable over the recited combination. For similar reasons claim 8 is also allowable over the recited combination.

Claims 9-10 and 17-18

Claim 9 recites the features of a differential including a differential gear assembly supported by a differential case, and wherein the ring gear is attached to the differential case to drive the differential gear assembly with the shift collar moving into locking engagement with the differential case to achieve a locked position. For the reasons set forth above with regard to claim 1, Keller does not disclose a differential having a differential case that is locked to a shift collar as claimed, see Figure 1.

Further, claim 9 recites that the resilient member surrounds the shift collar and reacts between the electronic actuator and the shift collar. For the reasons set forth above, neither reference discloses this claimed combination of features.

Finally, for the reasons set forth above with regard to claim 1, appellant respectfully asserts that there is no motivation or suggestion to modify Keller in the manner proposed by the examiner because Keller teaches away from the proposed modification. Thus, claim 9 is allowable over the recited combination. For similar reasons claims 10 and 17-18 are also allowable.

Claim 12

For the reasons set forth above with regard to claim 9, claim 12 is also allowable. Further, claim 12 recites the feature of a washer that is fixed to an outboard end of the shift collar such that the resilient member reacts between the washer and the coil, and with the coil being positioned axially between the inboard end of the shift collar and the washer.

The examiner argues that Petzold discloses a washer 22 mounted to a shift collar 18; however, the location of this element 22 is not at either end of the shift dog 18. Instead, Petzold teaches a central mounting of disc 22. The central location of this disc facilitates the ability of the shift dog to move equally toward opposite gear engagements in combination with providing a neutral (non-engaged) position axially between the two opposing gears. See col. 2, line 51 through col. 3, line 17; and col. 3, lines 52-63. Thus, claim 12 is allowable because the combination of references does not disclose, suggest, or teach the claimed invention.

Claim 13

For the reasons set forth above with regard to claim 1, there is no motivation or suggestion to modify Keller in the manner proposed by the examiner because Keller teaches away from the proposed modification.

Further, claim 13 recites that the resilient member reacts between the coil and a washer mounted to the outboard end of the shift collar. As discussed above with regard to claim 12, neither Keller nor Petzold discloses or suggests this feature. Instead, as discussed above with regard to claim 12, Petzold teaches away from such a configuration by disclosing a beneficial configuration where a disc 22 is centrally mounted on a shift dog 18. Thus, claim 13 is also allowable over the recited combination for this additional reason.

Claims 14-16

For the reasons set forth above with regard to claim 13, claim 14 is also allowable. Further, claim 14 recites the combination of a ring gear attached to a differential case that includes a first case half and a second case half attached to the first case half and wherein the electronic actuator selectively draws the shift collar into direct engagement with one of the first and second case halves. Keller does not disclose direct engagement between a differential case half and a shift collar as claimed, see Figure 1. Thus, claim 14 is allowable over the recited combination. For similar reasons claims 15-16 are also allowable over the recited combination.

Claim 19

For the reasons set forth above with regard to claim 17, claim 19 is also allowable. Further, claim 19 recites the step of providing driving input to the differential by providing a pinion gear for driving a ring gear attached to the differential case which comprises a first case half and a second case half; and wherein step (c) further includes moving the shift collar into direct engagement with one of the first and second case halves to fix the shift collar for rotation with the first and second case halves. Keller does not disclose direct engagement between a differential case half and a shift collar as claimed, see Figure 1. Thus, claim 19 is allowable over the recited combination.

Claim 20

For the reasons set forth above with regard to claim 17, claim 20 is also allowable. Further, claim 20 recites that the shift collar includes an inboard end that engages the differential case and an outboard end that has a smaller diameter than the inboard end, and recites the steps of fixing a washer to the outboard end of the shift collar, positioning the coil axially between the inboard end and the washer, and reacting the resilient member between the coil and the washer

The examiner argues that Petzold discloses a washer 22 mounted to a shift collar 18; however, as discussed above, the location of this element 22 is not at either end of the shift dog 18. Instead, Petzold teaches a central mounting of disc 22 to facilitate the ability of the shift dog to move equally toward opposite gear engagements in combination with providing a neutral (non-engaged) position axially between the two opposing gears. <u>See col. 2, line 51 through col. 3, line 17; and col. 3, lines 52-63</u>. Thus, claim 20 is allowable because the combination of references does not disclose, suggest, or teach the claimed invention.

Claim 24

For the reasons set forth above with regard to claim 1, claim 24 is also allowable. Further, claim 24 recites that the shift collar includes a first end having a splined surface to engage a mating splined surface of the differential case and a second end opposite of the first end, with the first end having a greater diameter than the second end, and wherein a washer is

fixed to the second end such that the resilient member reacts between the washer and the electronic actuator.

Keller does not disclose the claimed washer. Petzold does not disclose a washer that is positioned at an end of a shift collar as claimed. Further, the shift dog in Petzold is defined by a common diameter at each end. The shift dog 18 includes a central notch that receives the disc. Thus, Petzold teaches away from mounting a washer to one end of a shift collar that has a smaller diameter than the end of the shift collar that has the splined surface. Thus, claim 24 is allowable over the recited combination because the references do not disclose, suggest, or teach the claimed invention.

Claim 25

For the reasons set forth above with regard to claim 24, claim 25 is also allowable. Further, claim 25 recites that the electronic actuator includes a coil that is positioned axially between the first end and the washer, and wherein the resilient member is positioned axially between the washer and the coil. None of the references disclose, suggest, or teach the features set forth in claim 25.

Keller does not disclose a washer and Petzold teaches locating a disc at a central location on a shift dog 18. Further, Petzold teaches positioning an electromagnetic device 40 at an end of the shift dog 18 with a spring plate 46 positioned to react between the device 40 and the centrally located disc 22. Thus, neither reference discloses a spline surface at one end, a washer fixed to an opposite end, and a resilient member that is positioned between a washer and coil as claimed. Thus, claim 25 is allowable over the recited combination.

Claim 27

For the reasons set forth above with regard to claim 13, claim 27 is also allowable. Further, claim 27 recites that the coil is positioned axially between the inboard end and the washer. For the reasons set forth above with regard to claim 25, the references do not disclose, suggest, or teach this feature.

<u>B. Obviousness Rejection – Keller, Petzold, and Fogelberg</u>

Claims 11 and 26 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Keller (US 5030181) in view of Petzold (US 6886425) and further in view of Fogelberg (US 4561520).

<u>Claim 11</u>

For the reasons set forth above with regard to claim 10, claim 11 is also allowable. Further, claim 11 recites the feature of an axle housing for substantially enclosing the carrier and the pair of axle shafts wherein the coil includes mount portions to receive fasteners to directly secure the coil to the axle housing.

The examiner argues that while Keller and Petzold do not disclose the features of claim 11, Fogelberg teaches a coil 48 attached to a housing 12. The examiner argues that it would be obvious to modify Keller to include a coil that is mounted to an axle housing as taught by Fogelberg as a simple substitution of one known method for another. Appellant respectfully asserts that there is no motivation or suggestion to modify Keller in the manner proposed by the examiner.

As discussed above with regard to claim 1, the proposed modification cannot render the prior art unsatisfactory for its intended purpose (see MPEP 2143.01 (V)) and cannot change the principle of operation of a reference (see MPEP 2143.01 (VI)). Appellant respectfully asserts that Keller teaches away from the examiner's proposed modification. Keller discloses a beneficial configuration with an insert bushing that includes a ring magnet that can be separately installed as a unit within a housing. <u>See col. 1, lines 46-68; col. 2, line 66 through col. 3, line 2; col. 5, lines 10-16; claim 1; and Figure 1</u>. Modifying Keller in the manner proposed by the examiner would require that magnet 16 be removed from the pre-assembled unit 10 such that it could be mounted to the axle housing. This would clearly defeat the benefits provided by Keller. Thus, claim 11 is allowable over the recited combination because Keller teaches away from the proposed modification.

Claim 26

For the reasons set forth above with regard to claim 1, claim 26 is also allowable. Further, claim 26 recites that the electronic actuator includes a coil having mount portions to receive fasteners to directly attach the coil to a carrier housing. Keller and Petzold do not disclose a coil having mount portions as claimed. The examiner relies on Fogelberg to teach this feature; however, for the reasons set forth above with regard to claim 11, there is no motivation or suggestion to modify Keller with the teachings of Fogelberg in the manner proposed by the examiner because Keller teaches away from the proposed modification. Thus, claim 26 is allowable over the recited combination.

CONCLUSION

For the reasons set forth above, the rejection of all claims is improper and should be reversed. Appellant earnestly requests such an action.

Respectfully submitted,

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Dated: February 5, 2009

CLAIMS APPENDIX

1. A differential locking mechanism for a drive axle comprising:

a differential including a differential gear assembly supported within a differential case;

a pair of axle shafts driven by said differential gear assembly for rotation about an axis;

a shift collar movable between an unlocked position where speed differentiation between said pair of axle shafts is permitted and a locked position wherein said shift collar directly engages said differential case such that said differential case, said shift collar, and said pair of axle shafts are fixed for rotation together;

an electronic actuator responsive to an electronic signal to move said shift collar from said unlocked position to said locked position; and

a resilient member that returns said shift collar to said unlocked position, said resilient member surrounding an outer end portion of said shift collar.

2. The differential locking mechanism as set forth in claim 1 wherein said electronic actuator includes a coil mounted to an axle component and surrounding said shift collar wherein said electronic signal powers said coil to move said shift collar.

3. The differential locking mechanism as set forth in claim 2 wherein said differential case includes a first case half and a second case half and wherein said electronic actuator selectively moves said shift collar to engage one of said first and second case halves.

4. The differential locking mechanism as set forth in claim 2 wherein said resilient member automatically returns said shift collar to said unlocked position when said coil is not powered.

5. The differential locking mechanism as set forth in claim 4 wherein said resilient member reacts between said coil and an outboard end of said shift collar.

6. The differential locking mechanism as set forth in claim 5 including a washer fixed to said outboard end for reacting with said resilient member.

7. The differential locking mechanism as set forth in claim 2 wherein said shift collar includes an inboard end having a splined surface and an outboard end for supporting said resilient member, said inboard end having a greater diameter than said outboard end.

8. The differential locking mechanism as set forth in claim 7 wherein said coil defines a central bore surrounding said shift collar at said outboard end, said shift collar moving in an inboard direction in response to said coil being powered via said electronic signal such that said splined surface of said inboard end engages a mating splined surface formed on said differential case such that said differential case and said pair of axle shafts are locked together for rotation about said axis.

9. A drive axle assembly with a locking differential comprising:

a driving input defining a longitudinal axis;

a carrier including a pinion gear driven by said driving input and a ring gear in meshing engagement with said pinion gear;

a differential including a differential gear assembly supported by a differential case wherein said ring gear is attached to said differential case to drive said differential gear assembly;

a pair of axle shafts driven by said differential gear assembly for rotation about a lateral axis, said lateral axis being transverse to said longitudinal axis; and

a locking mechanism including a shift collar and an electronic actuator for controlling movement of said shift collar wherein said shift collar is movable between an unlocked position where speed differentiation between said pair of axle shafts is permitted and a locked position wherein said shift collar is moved into locking engagement with said differential case in response to an electronic signal such that said differential case, said shift collar, and said pair of axle shafts are fixed for rotation together about said lateral axis, and wherein said locking mechanism

includes a resilient member that returns said shift collar to said unlocked position, said resilient member surrounding said shift collar and reacting between said electronic actuator and said shift collar.

10. The drive axle assembly as set forth in claim 9 wherein said electronic actuator comprises a coil surrounding said shift collar wherein said electronic signal powers said coil to move said shift collar.

11. The drive axle assembly as set forth in claim 10 including an axle housing for substantially enclosing said carrier and said pair of axle shafts wherein said coil includes mount portions to receive fasteners to directly secure said coil to said axle housing.

12. The drive axle assembly as set forth in claim 10 wherein said shift collar includes an inboard end having a splined surface and an outboard end, said inboard end having a greater diameter than said outboard end and wherein said coil defines a central bore surrounding said shift collar at said outboard end, said shift collar moving in an inboard direction in response to said coil being powered via said electronic signal such that said splined surface of said inboard end engages a mating splined surface formed on said differential case such that said differential case is locked to said pair of axle shafts, and wherein a washer is fixed to said outboard end such that said resilient member reacts between said washer and said coil, said coil being positioned axially between said inboard end of said shift collar and said washer.

13. A drive axle assembly with a locking differential comprising:

a driving input defining a longitudinal axis;

a carrier including a pinion gear driven by said driving input and a ring gear in meshing engagement with said pinion gear;

a differential including a differential gear assembly supported by a differential case wherein said ring gear is attached to said differential case to drive said differential gear assembly;

a pair of axle shafts driven by said differential gear assembly for rotation about a lateral axis, said lateral axis being transverse to said longitudinal axis;

a locking mechanism including a shift collar and an electronic actuator for controlling movement of said shift collar wherein said shift collar is movable between an unlocked position where speed differentiation between said pair of axle shafts is permitted and a locked position, and wherein said shift collar is moved into locking engagement with said differential case in response to an electronic signal such that said differential case, said shift collar and said pair of axle shafts are fixed for rotation together about said lateral axis, and wherein said electronic actuator comprises a coil surrounding said shift collar wherein said electronic signal powers said coil to move said shift collar;

wherein said shift collar includes an inboard end having a splined surface and an outboard end, said inboard end having a greater diameter than said outboard end and wherein said coil defines a central bore surrounding said shift collar at said outboard end, said shift collar moving in an inboard direction in response to said coil being powered via said electronic signal such that said splined surface of said inboard end engages a mating splined surface formed on said differential case such that said differential case is locked to said pair of axle shafts;

an axle housing for substantially enclosing said carrier and said pair of axle shafts wherein said coil is supported by said axle housing; and

a resilient member for automatically returning said shift collar to said unlocked position when said coil is not powered, said resilient member reacting between said coil and a washer mounted to said outboard end of said shift collar.

14. The drive axle assembly as set forth in claim 13 wherein said differential case includes a first case half and a second case half attached to the first case half and wherein said electronic actuator selectively draws said shift collar into direct engagement with one of said first and second case halves.

15. The drive axle assembly as set forth in claim 14 including a pair of side gears with one side gear being fixed to each of said pair of axle shafts and wherein said differential gear

assembly includes a differential spider having four support shafts orientated in an overall shape of a cross and four differential pinion gears in meshing engagement with said side pair of gears with one of said four differential pinion gears being supported on each of said four support shafts and wherein said ring gear is fixed to one of said first and second case halves such that said ring gear, said differential case, said differential spider, and said four differential pinion gears all rotate as one unit to transfer power to said pair of axle shafts via said pair of side gears when no speed differentiation is required and when speed differentiation is required said four differential pinion gears rotate on respective support shafts to speed up rotation of one of said pair of axle shafts via a respective one of said pair of side gears while slowing rotation of the other of said pair of axle shafts via a respective other of said pair of side gears.

16. The drive axle assembly as set forth in claim 15 wherein one of said pair of axle shafts includes a set of inboard splines and a set of outboard splines, said set of inboard splines cooperating with said respective one of said pair of side gears to fix said one of said pair of side gears for rotation with said one of said pair of axle shafts and said set of outboard splines cooperating with a splined bore formed inside said inboard end of said shift collar.

17. A method for controlling a differential lock assembly for a drive axle comprising the steps of:

(a) providing a differential for driving a pair of axle shafts, the differential including a differential gear assembly supported within a differential case and a shift collar for selective engagement with the differential case;

(b) energizing a coil surrounding the shift collar;

(c) in response to step (b) moving the shift collar from an unlocked position where speed differentiation between the pair axle shafts is permitted under predetermined conditions to a locked position where the pair of axle shafts rotate at a common speed by fixing the shift collar to the differential case; and

(d) providing a resilient member that surrounds an end portion of the shift collar and reacts between the coil and a portion of the shift collar, and returning the shift collar from the

locked position to the unlocked position with the resilient member when the coil is no longer energized.

18. The method as set forth in claim 17 including the step of automatically returning the shift collar to the unlocked position when the coil is not energized.

19. The method as set forth in claim 18 including the step of providing driving input to the differential by providing a pinion gear for driving a ring gear attached to the differential case which comprises a first case half and a second case half; and wherein step (c) further includes moving the shift collar into direct engagement with one of the first and second case halves to fix the shift collar for rotation with the first and second case halves.

20. The method as set forth in claim 18 wherein the shift collar includes an inboard end that engages the differential case and an outboard end that has a smaller diameter than the inboard end, and including fixing a washer to the outboard end of the shift collar, positioning the coil axially between the inboard end and the washer, and reacting the resilient member between the coil and the washer.

24. The differential locking mechanism as set forth in claim 1 wherein said shift collar includes a first end having a splined surface to engage a mating splined surface of said differential case and a second end opposite of said first end, said first end having a greater diameter than said second end, and wherein a washer is fixed to said second end such that said resilient member reacts between said washer and said electronic actuator.

25. The differential locking mechanism as set forth in claim 24 wherein said electronic actuator includes a coil that is positioned axially between said first end and said washer, and wherein said resilient member is positioned axially between said washer and said coil.

26. The differential locking mechanism as set forth in claim 1 wherein said electronic actuator includes a coil having mount portions to receive fasteners to directly attach said coil to a carrier housing.

27. The drive axle assembly as set forth in claim 13 wherein said coil is positioned axially between said inboard end and said washer.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None